

1. A credit-based system for determining a transmit rate from a sender guaranteeing the prevention of underflow and overflow conditions, comprising:

- (a) receiver processing apparatus which receives data packets;
- (b) storing apparatus, which receives and stores the data packets from the first processing apparatus;
- (c) threshold apparatus for updating transmit rates with fixed period coupled to a register apparatus for receiving the updated transmit rate; and
- (d) apparatus for communicating an updated transmit fraction to a sender.

2. The receiver of Claim 1 wherein the threshold circuit apparatus further comprises:

- (e) a first logic apparatus which calculates an underflow threshold (T1) for the storage apparatus using queuing analysis, having regard to the inequalities

$$T1 > Q_{max}/8 \quad \text{Eq(a)}$$

$$T2 < 15 * Q_{max}/16 \quad \text{Eq(b)}$$

$$T1 \leq T2 - Q_{max}/16 \quad \text{Eq(c)}$$

3. The receiver of Claim 1 wherein the threshold circuit apparatus further comprises:

(f) a second logic apparatus which calculates an overflow threshold (T2) for the storage apparatus using queuing analysis likewise having regard to the inequalities

$$T1 > Q_{\max}/8 \quad \text{Eq(a)}$$

$$T2 < 15 \cdot Q_{\max}/16 \quad \text{Eq(b)}$$

$$T1 \leq T2 - Q_{\max}/16 \quad \text{Eq(c)}$$

4. The receiver of Claim 1 wherein the updated transmit fraction apparatus further comprises:

(g) a first logic apparatus which calculates a first selected transmit fraction update where the storing apparatus contains a quantity of the data packets between thresholds T1 and T2.

5. The receiver of Claim 1 wherein the updated transmit fraction apparatus further comprises:

(h) a second logic apparatus which calculates a second selected credit update value where the storing apparatus contains a quantity of the data packets between thresholds less than T1.

1 6. The receiver of Claim 1 wherein the updated transmit fraction apparatus further
2 comprises:
3 (i) a third logic apparatus which calculates a third selected credit update value
4 where the storing apparatus contains a quantity of the data packets between thresholds is greater
5 than T2.

1 7. The receiver of Claim 1 further comprising:
2 (j) second processing apparatus to which the updated transmit fraction is
3 communicated.

1 8. The receiver of Claim 1 further comprising:
2 (k) communication apparatus which transmits an updated transmit rate to a
3 sender.

1 9. The receiver of Claim 1 further comprising:
2 (l) threshold setting apparatus which at initialization selects the values of the
3 thresholds set in the storage apparatus.

1 10. The receiver of Claim 1 further comprising:
2 (m) connecting apparatus which connects the register apparatus in the receiver
3 to the update transmit rate register in the sender.

11. A communication system for preventing overflow and underflow in a receiver,
comprising:

- (a) a sender sending data at a selected transmit rate (T_r) to the receiver;
- (b) storage apparatus with occupancy (Q) in the receiver for storing the data;
- (c) transmit rate generating apparatus, which generates a transmit rate (T_r) as a feedback signal to the sender in a regular time interval (D_t) for controlling T_r ;
- (d) threshold apparatus which establishes threshold T_1 in Q indicative of the least storage in Q to prevent underflow and threshold T_2 indicative of a maximum storage in Q to prevent overflow;
- (e) queue monitoring apparatus which determines the level of data storage in the queue at regular time intervals; and
- (f) computing apparatus which compares Q to T_1 or T_2 and communicates to the sender a transmit rate (T_r), every D_t time units where $T_r = 0$ when $T_2 \leq Q \leq Q_{\max}$; $T_r = \text{Max}/2$ when $T_1 \leq Q < T_2$ and $T_r = \text{Max}$ when $0 \leq Q < T_1$.

12. The system of Claim 11 further comprising:

- (g) initialization algorithm which chooses D_t to be greater than the sum of transmission signal and receiver processing delays.

13. The system of Claim 11 further comprising:

- (h) initialization algorithm which chooses D_t to be less than the value $Q_{\max}/(\text{Max} \cdot 8)$ where Q_{\max} is maximum storage capacity of data in the receiver and Max is the maximum sending rate possible from the sender.

1 14. The system of Claim 11 further comprising

2 (i) communication apparatus for transmitting the transmit rate from the
3 receiver unit to the sender as a feedback signal controlling the transmit rate.

1 15. In a communication system, a method for preventing overflow and underflow in a
2 receiver comprising the steps of:

3 (a) transmitting data at a selected transmit rate T_r from the sender to the
4 receiver;

5 (b) temporarily storing data awaiting processing in a storage apparatus Q;

6 (c) generating a transmit rate (T_r) as a feedback signal to the;

7 (d) establishing a threshold T_1 in the Q indicative of the least storage in the Q
8 to prevent underflow;

9 (f) establishing a threshold T_2 in the Q indicative of the maximum storage in
10 the Q to prevent overflow;

11 (g) determining the level of data storage Q in the queue at regular intervals of
12 duration D_t ; and computing and communicating a transmit rate T_r every D_t time units where T_r
13 = 0 when $T_2 \leq Q \leq Q_{max}$; $T_r = \text{Max}/2$ when $T_1 \leq Q < T_2$ and $T_r = \text{Max}$ when $0 \leq Q <$
14 T_1 .

1 16. The method of Claim 15 further comprising the step of:

2 (h) choosing D_t to be greater than the sum of transmission signal and receiver
3 processing delays.

1 17. The method of Claim 15 further comprising the step of:

2 (i) limiting the value of Dt to be less than the value $Q_{max}/(Max*8)$ where

3 Q_{max} is maximum storage capacity of data in the receiver and Max is the maximum sending rate
4 possible from the sender.

1 18. The method of Claim 15 further comprising the step of:

2 (j) communicating the transmit rate from the receiver unit to the sender as a

3 feedback signal controlling the transmit rate.

1 19. A medium, executed in a computer system, for preventing overflow and
2 underflow in a receiver comprising:

3 (a) program instruction transmitting data from a sender to a receiver at a
4 transmit rate (Tr) refreshed with regular period (Dt);

5 (b) program instruction storing the data in a storage apparatus Q in the
6 receiver;

7 (c) program instruction generating a transmit rate (Tr) as a feedback signal to
8 the sender in a regular interval (Dt) for controlling the transmit rate Tr ;

9 (d) program instruction establishing a threshold $T1$ in the Q indicative of the
10 least storage in the Q to prevent underflow;

11 (e) program instruction establishing a threshold $T2$ in the Q indicative of the
12 maximum storage in the Q to prevent overflow;

13 (f) program instruction determining the level of data storage in the queue at
14 credit intervals; and

15 program instruction computing and transmitting a transmit rate
 16 every Dt time units where where $Tr = 0$ when $T2 \leq Q \leq Q_{max}$; $Tr = Max/2$ when $T1 \leq Q <$
 17 $T2$ and $Tr = Max$ when $0 \leq Q < T1$.
 18 .

1 20. The medium of Claim 19 further comprising the step of:

2 (g) program instruction choosing at initialization the value Dt to be greater
 3 than the sum of transmission signal and receiver processing delays.

1 21. The medium of Claim 19 further comprising the step of:

2 (h) program instruction choosing at initialization the value Dt to be less than
 3 the value $Q_{max}/(Max*8)$ where Q_{max} is maximum storage capacity of data in the receiver and
 4 Max is the maximum sending rate possible from the sender.

1 22. The medium of Claim 19 further comprising the step of:

2 (i) program instruction communicating the transmit rate from the receiver
 3 unit to the sender as a feedback signal controlling the transmit rate.